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Facial Expressions of Emotion: An Old Controversy and New Findings [and Discussion]

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Facial expressions of emotion: an old controversy and new findings

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SUMMARY

Evidence on universals in facial expression of emotion and renewed controversy about how to interpret that evidence is discussed. New findings on the capability of voluntary facial action to generate changes in both autonomic and central nervous system activity are presented, as well as a discussion of the possible mechanisms relevant to this phenomenon. Finally, new work on the nature of smiling is reviewed which shows that it is possible to distinguish the smile when enjoyment is occurring from other types of smiling. Implications for the differences between voluntary and involuntary expression are considered.

1. INTRODUCTION

I begin with a very old question, which was the starting point for my research on the face: are there universal facial expressions of emotion? There are three reasons for reviewing the evidence on this question, most of which is 20 years old. First, it is the foundation for the three new discoveries about the face, which I will later describe: (i) that voluntarily performed facial actions can generate emotion-specific physiology; (ii) the identification of which of the many smiles signals enjoyment; and (iii) the development of new methods for measuring visible facial action. My second reason for reconsidering the universality question is that misunderstanding and controversy continues about the nature of the evidence and what it means. Third, new findings on cultural differences in facial expression which I will present can be best understood in the context of the earlier work.

2. UNIVERSAL FACIAL EXPRESSIONS

From 1920 until 1960 many influential psychologists (see, for example, Bruner & Tagiuri 1954; Hunt 1941; Klineberg 1938; Landis 1924; Munn 1940) maintained that facial expressions are socially learned and culturally variable, with no fixed relation between an expression and what it signifies. In the early 1970s there were two challenges: a critical re-evaluation of the experiments that had supported that position (Ekman *et al.* 1972); and, more importantly, new cross-cultural data. Izard (1971), and also Friesen and Ekman, conducted similar studies of literate cultures, working independently but at the same time. We were directly influenced by Tomkins' writings on emotion (1962), and his advice on the conduct of the research we performed.

In each culture, subjects chose the emotion term which fit photographs of posed Caucasian facial expressions. Although Izard and I each showed different photographs, gave the subjects somewhat different lists of emotion terms, and examined people in different cultures, we both obtained consistent evidence of agreement across more than a dozen Western and non-Western literate cultures in the labelling of enjoyment, anger, fear, sadness, disgust and surprise facial expressions.

To rule out the possibility that such agreement could be a result of members of every culture having learned expressions from a shared mass media input, Friesen and I also studied a visually isolated preliterate culture in New Guinea (Ekman *et al.* 1969; Ekman & Friesen 1971). We replicated our literate culture findings, as did Heider & Rosch (as reported in Ekman 1972) a few years later in another visually isolated culture in what is now West Irian. Although surprise expressions were distinguished from anger, fear, sadness, disgust and enjoyment expressions in both pre-literate cultures, surprise was not distinguished from fear expressions in one of the preliterate, visually isolated cultures. Friesen and I also reversed the research design and found that when New Guineans posed facial expressions they were understandable to Western observers.

To reconcile these findings of universality with the many reports by cultural anthropologists of dissimilar facial expressions, we (Ekman & Friesen 1969) postulated display rules to describe what we presumed cultures teach their members about the management of expression in social contexts. Cultural variations in display rules could explain how universal expressions might be modified in social situations to create the impression of culture-specific facial expressions of emotion. We tested this idea in a study which com-

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pared the spontaneous expressions of Japanese and Americans. In each country we videotaped subjects when they were alone, and presumably no display rules should operate, and when they were with another person. As predicted, there was no difference between cultures in the expressions shown in response to emotion-inducing films when the subjects thought they were alone. However, when an authority figure was present the Japanese more than the Americans masked negative expressions with the semblance of smile.

We and Izard interpreted the evidence as showing universal facial expressions as posited by Tomkins (1962), Plutchik (1962) and by Darwin (1872). Consistent with an evolutionary view of expression were other reports of similarities in expression in other primates and early appearance developmentally. Recently, there have been some challenges to that interpretation. Lutz & White (1986) cite anthropologists who regard emotions as social constructions and report cultures in which the emotions proposed as universal are neither named nor expressed. Unfortunately such reports are not substantiated by quantitative methods nor protected against the potential for bias or error when the information is obtained by the single observer who formulated the hypothesis under study. There are no replicated findings, with safeguards against bias and data on inter-observer reliability, that a facial expression signifies entirely different emotions in two cultures.

Ortony & Turner (1990) provided a different challenge, speculating that it is only the components of expressions, not the full emotional expressions, which are universal. However, there is no evidence to support their contention, and their claims contradict what is known about the muscular basis for facial expression (Ekman 1992). Their challenge to the evidence on universals in expression was borne out of their desire to reject the theoretical position that there are any emotions that should be considered basic. Their stance requires them also to dismiss developmental, phylogenetic and physiological evidence consistent with an evolutionary view of facial expressions of emotion.

A new line of studies has identified one way in which cultures do differ in regard to facial expression. Ekman *et al.* (1987) reported consistent evidence of cultural differences in the perception of the strength of an emotion rather than which emotion is shown in a facial expression. Japanese made less intense attributions than did Americans, regardless of the emotion shown or whether the person showing the emotion is Japanese or American, male or female (Matsumoto & Ekman 1989). This difference appears to be specific to the interpretation of facial expressions of emotions, as it was not found in the judgement of either non-facial emotional stimuli or facial non-emotional stimuli (Matsumoto 1992).

A number of empirical questions remain about universals in facial expression. We do not know how many expressions for each emotion are universal, for no one has systematically explored a variety of expressions for each emotion in multiple cultures. Nor is there certain knowledge about whether there are other emotions that have universal expressions. There is some evidence, but it is contradictory, for universal facial expressions for contempt, interest, shame and guilt. Little is known also about cross-cultural differences in display rules, as a function of sex, role, age and social context (but see recent work by Matsumoto (1991)).

3. FACIAL ACTION GENERATES EMOTION PHYSIOLOGY

Most emotion theorists emphasize the involuntary nature of emotional experience, ignoring those instances in which people choose to generate an emotion through reminescence or by adopting the physical actions associated with a particular emotion (e.g. speaking more softly to de-intensify anger, or smiling to generate enjoyment). Facial expression from this vantage point is seen as one of several emotional responses, and is generated centrally when an emotion is called forth by an event, memory, image, etc.

A new role for facial expression was found in my collaborative study with Levenson and Friesen (Ekman *et al.* 1983). Voluntarily performing certain facial muscular actions generated involutary changes in autonomic nervous system (ANS) activity. We did not ask subjects to pose emotions, but instead to follow muscle-by-muscle instructions to create on their face one of the expressions that had been found to be universal. For example, rather than ask a subject to pose anger we said: 'pull your eyebrows down and together, raise your upper eyelid and tighten your lower eyelid, narrow your lips and press them together'. There was greater heart rate acceleration and increased skin conductance when subjects made the expressions for negative emotions (anger, disgust and fear) than the positive emotion of happiness. There was greater heart rate acceleration when subjects made the expression for anger, fear and sadness than for disgust, and increased finger temperature in anger as compared with fear.

This work has since been replicated in three more experiments (Levenson *et al.* 1990; Levenson *et al.* 1991), and a number of a possible artefacts which could have been responsible for this phenomenon have been ruled out: it occurs when subjects cannot see their own faces or the face of the person giving the instructions; it is not an artefact of somatic muscle activity; and it does not result from differences in the difficulty of making the different facial configurations. The result that voluntary facial action generates different patterns of ANS activity was also replicated in an older population (Levenson *et al.* 1991). We also did the experiment in another culture to determine whether our findings are specific to Americans or are more general. We selected a cultural group – the Minangkabau of Sumatra – who differ from Western societies in language, religion (fundamentalist Moslem) and social organization (they are matrilineal, with inheritance through the mother's side of the family). Our findings were replicated (Levenson *et al.*

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1992) suggesting that this phenomenon may be pancultural.

I will focus now on issues relevant to the fact that voluntary facial action generated physiological changes. The nature of the physiological changes themselves have been discussed elsewhere (Ekman 1984; Ekman *et al.* 1983; Levenson *et al.* 1990). First, let us consider whether these voluntary facial muscular performances generate emotion or only the physiology of emotion. The problem in answering that question is what to use as the criterion for emotion. We could not use either the face, which generated the response, or the physiological changes which occurred when the facial actions were made, as we wanted to know whether an emotion is experienced when these physiological changes are generated. We had to rely instead upon self report, which is notoriously vulnerable to demand characteristics. We tried to minimize that by asking an open-ended question, and by including in that question a probe also about any physical sensations or memories. Few sensations or memories were reported, although in 78% of the trials the subjects reported feeling an emotion. When subjects reported actually feeling the emotion associated with the expression they made, the ANS distinctions among the negative emotions were more pronounced. Clearly, considerably more research is needed to be certain that people actually are experiencing emotions in this task. Different self-report procedures should be used, perhaps also with manipulations about expectations, to learn how subjects construe the physiological changes which occur when they make the facial muscular actions.

A question also can be raised about whether the changes in ANS activity generated when subjects make the different facial expressions are unique to this specific task or would occur when emotion is brought about by more usual means. This raises the general question about whether ANS patterning is emotion specific or context specific (see a recent discussion by Stemmler (1989)). I have proposed (Ekman 1984, 1992) that the changes in both physiology and expression are emotion specific, but the results on this issue in the first study (Ekman *et al.* 1983) were not clear cut. We found both similarities and differences in the specific ANS patterns generated by the voluntary facial action task and by a task in which subjects were instructed to relive past emotional experience. Recently (Levenson *et al.* 1991) we obtained more consistent results, finding the same distinctions among negative emotions in ANS activity in both the voluntary facial action task and in the relived emotion task. Work now in progress is comparing the ANS activity which occurs with these two tasks and a task in which emotions are aroused by viewing short motion picture films.

The same question – are any observed patterns of activity emotion specific or task specific – can be asked about any emotional response, not just ANS physiology. Although there has been no specific study aimed at answering this question for facial activity, there is considerable evidence to suggest that the facial configuration (the specific pattern of facial muscular activity) is more emotion specific than task specific; attempts to control the expression, the timing of the configurational changes and the extent of activity all reflect the specifics of how the emotion was brought about. We are currently directly examining this issue for the face as well.

Before turning to the question of how voluntarily making different facial configurations generates different patterns of physiology, let me broaden our focus to consider CNS, not just ANS, physiology. I draw here on new findings in a collaboration with Richard Davidson from the University of Wisconsin. Exactly the same task was used in which subjects followed muscle-by-muscle instructions to create different facial configurations. Davidson and his colleagues measured left and right frontal, temporal and parietal EEG activity. Different patterns of EEG activity occurred when subjects made the muscular movements that had been found universally for the emotions of happiness, anger, fear, sadness and disgust. I will not report the nature of those differences because they have not yet been replicated, but they were large and, in all likelihood, should replicate.

There are three quite different explanations of how voluntary facial action generates emotion-specific physiology. The first explanation, which I endorse, posits a central, hard-wired connection between the motor cortex and other areas of the brain involved in directing the physiological changes that occur during emotion. Usually when emotions are aroused by perception of a social event a set of central commands produce patterned emotion-specific changes in multiple systems, including (but not limited to) such peripheral systems as facial expressions, vocalizations, skeletal muscular settings and ANS activity. When there is no emotion operative, as in our experiments, but one set of those commands is generated deliberately, the established emotion networks transmit the same patterned information thereby generating the other emotion-specific response changes. The initiating actions need not be a facial expression; emotion-specific vocalizations or respiratory patterns, for example, should do just as well. (We have preliminary data to support the idea that deliberately made vocalizations generate emotion-specific ANS changes.)

A second group of alternative explanations propose that any connection between expression and physiological change is learned not hard wired. The extreme version of this viewpoint sees emotions as totally socially constructed, and has no reason to expect that there always will be both an expression and a unique pattern of physiology in every emotion, let alone any connection beween the two. Emotion-specific ANS activity might only be learned in those cultures that teach its members specific adaptive behaviours for an emotion, and there would be no reason for every culture to do so, or if they did, to teach the same adaptive pattern. If anger exists in two cultures, and it certainly need not in every culture, there would be no necessary reason why anger would be associated with fighting and the physiology that subserves such actions in any two cultures. Nor would there be any reason for expressions to be learned and associated with any

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physiology. Our findings (Levenson *et al.* 1991) of the same emotion-specific ANS physiology, and the capability for voluntary facial action to generate that activity, in a Moslem, matrilineal Indonesian culture challenge such a radical social constructivist view. A more moderate social learning position, which allowed for universals in both expression and in physiology, might still claim that the link between the two is learned not hard wired, established through repeated co-occurrence.

A third set of alternative explanations emphasizes peripheral feedback from the facial actions themselves, rather than a central connection between the brain areas which direct those facial movements and other brain areas. This view includes variations in terms of whether it is feedback from the muscles, skin, or temperature changes, and whether it is hard wired or requires learning. This explanation is consistent with the views of Izard, Laird, Tomkins and Zajonc.

For now, there is no clear empirical basis for a definitive choice among these explanations. We hope, through studies of people with facial paralysis who have no possibility of peripheral facial action or feedback, to challenge that explanation. If there is a direct central connection, and if these people know how to deliberately and accurately command their facial muscles to contract, then we should observe patterned changes in their physiology, even though no facial action occurs. That study is not yet complete, and the results may not be unambiguous. The findings may be negative, not because the mechanism is not a central one, but because these patients may not be able to follow the instructions to attempt to contract specific facial muscles. We have with them no way to verify, as we can with normal subjects, that they actually produced the required facial muscle configuration.

4. THE SMILE OF ENJOYMENT

Failing to recognize that there are different types of smiling which may have different meanings has confused both psychologists and anthropologists. The appearance of smiling of some form in unpleasant circumstances led anthropologists such as Birdwhistell (1963, 1970) and LaBarre (1947) to proclaim that facial expressions are culture specific. Birdwhistell, for example, described how, early in his research, he was preoccupied '. . . with human universals, [and] I attempted to study the human smile . . . Not only did I find that a number of my subjects "smiled" when they were subjected to what seemed to be a positive environment but some "smiled" in an aversive one . . .' (1970, pp. 29–30). 'This search for universals was culture bound . . . There are probably no universal symbols of emotional state . . . [expressions are] learned and patterned according to the particular structure of particular societies' (1963, p. 126).

Within psychology the conclusion that facial expressions do not provide much accurate information about emotion – the position taken in Hunt's (1941) and Bruner & Tagiuri's (1954) influential literature reviews – relied heavily upon experiments in which subjects smiled in unpleasant circumstances. The classic study by Landis (1924) found that subjects smiled as often when observing a rat being decapitated as when listening to music. More recently, studies of interpersonal deception have obtained contradictory findings on smiling (see review by Frank *et al.* (1992)).

The confusion might have been avoided if scientists in this century had read the French neuroanatomist Duchenne de Boulogne, who wrote in 1862. Although this work was not translated into English until recently (Duchenne 1990), Charles Darwin (1872) had described Duchenne's ideas about smiling in his own book on expression. Duchenne said that the smile of enjoyment could be distinguished from deliberately produced smiles by considering two facial muscles: zygomatic major, which pulls the lip corners up obliquely, and orbicularis oculi, which orbits the eye pulling the skin from the cheeks and forehead towards the eyeball. 'The first [zygomatic major] obeys the will but the second [orbicularis oculi] is only put in play by the sweet emotions of the soul; the . . . fake joy, the deceitful laugh, cannot provoke the contraction of this latter muscle' (1990, p. 126). '[This muscle] . . . does not obey the will; it is only brought into play by a true feeling . . . Its inertia in smiling unmasks a false friend' (1990, p. 72).

Duchenne's observation is consistent with our (Ekman *et al.* 1980) finding that most people cannot voluntarily contract the outer portion of the muscle that orbits the eye, and would therefore not be able to include this action when they deliberately smile. Duchenne had not distinguished between the inner and outer part of the orbicularis oculi muscle, but we found that most people can voluntarily contract the inner portion of the orbicularis oculi muscle. Therefore we modified Duchenne's formulation considering just the actions of outer part of this muscle crucial for distinguishing the smile of enjoyment.

We (Ekman & Friesen 1982) also suggested that enjoyment smiles could be distinguished from other forms of smiling by the presence of certain other muscles, and by the symmetry and the timing of the smile. I (Ekman 1985) have described eighteen different forms of smiling. I define enjoyment smiles as those smiles associated with pleasure, relief, amusement, etc. Non-enjoyment smiles include masking smiles (in which the smile at least partly covers muscular movements associated with another emotion), false smiles (smiles intended to mislead another into believing enjoyment is felt when it is not), miserable smiles (grin and bear it smiles), etc.

Although there has been some empirical support for each of the proposed markers which distinguish enjoyment from other smiling (see, for example, Ekman *et al.* (1988) on other muscular differences; Ekman *et al.* (1981) and Hager & Ekman (1985) on symmetry; Hess & Kleck (1992) on timing), the largest number of studies have examined Duchenne's observation. I will focus here just on this evidence which has confirmed Duchenne's hypothesis. In all of these studies the smile with contraction of the outer portion of the orbicularis oculi muscle (which in his honour I have called Duchenne's smile) is compared with other kinds

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of smiling which do not include that muscular action. Three types of evidence support Duchenne's distinction.

(*a*) *Social context*

We (Ekman *et al.* 1988) found more Duchenne smiles when subjects truthfully described pleasant feelings than when they followed instructions to claim to be feeling pleasant when they were actually watching very gruesome surgical films. In another study (Ekman *et al.* 1990) in which people were not asked to deceive but simply watched emotion-inducing films while alone, there were more Duchenne smiles when they watched pleasant as compared with unpleasant films, but no difference in how often other kinds of smiling occurred. Ten-month-old infants showed more Duchenne smiles when approached by their mother but more of other kinds of smiling when approached by a stranger (Fox & Davidson 1988). Five- to seven-year-old children showed more Duchenne smiles when they succeeded, and more other kinds of smiling when they failed, in a game (Schneider 1987). Psychiatrically depressed patients showed more Duchenne smiles at time of discharge from a hospital as compared with time of admission, with no difference in other kinds of smiling (Matsumoto 1987). Similarly, there was more Duchenne smiling in late, as compared with early, psychotherapy sessions, but only among patients who had improved (Steiner 1986).

(*b*) *Person*

Schizophrenic patients showed fewer Duchenne smiles than normal individuals but there was no difference between the groups in other kinds of smiling (Krause *et al.* 1989). Mothers who were referred to a clinic by the courts because they had abused their child showed less Duchenne smiles when interacting with a child than a control group of mothers who had evidenced no child abuse (Bugental *et al.* 1990). Levenson & Gottman found that happily married couples showed more Duchenne smiles than unhappily married couples, but there was no difference in other kinds of smiling (Levenson 1989).

(*c*) *Other emotional responses*

Only the Duchenne smile correlated with self reports of positive emotions after subjects had seen two films intended to induce positive effect, and only the Duchenne, not other kinds of smiling, predicted which of the positive films each subject reported liking best (Ekman *et al.* 1990). In that same study different patterns of regional brain activity were found when the subjects showed the Duchenne as compared with other smiles. The study of ten-month-old infants (Fox & Davidson 1988), also found differences in regional brain activity when the infants showed a Duchenne as compared with non-Duchenne smiles. My recent unpublished study with Davidson found different patterns of regional brain activity when subjects deliberately performed a Duchenne smile as compared with a non-Duchenne smile.

This is a remarkable convergence of evidence supporting the distinction between Duchenne and other kinds of smiling. No account should be taken of studies that claim to show that smiles are unrelated to emotion (see, for example, Fridlund 1991) which continue to treat all smiles as a single category, not separating Duchenne from non-Duchenne smiles.

Recent work has shown that the Duchenne smile is recognizable to observers who were able to distinguish enjoyment from non-enjoyment smiles when they viewed a series of smiles (Frank *et al.* 1992). The Duchenne smile was not related to observers' attributions when this type of smiling was embedded within the usual context competing for attention with speech content, voice and gesture (O'Sullivan *et al.* 1992).

One of the questions remaining about smiles is whether the different positive emotions (e.g. amusement, contentment, relief, etc.) have distinctive forms of smiling, or if the variety of positive emotions share one signal and can be inferred only from other behavioural or contextual cues. I presume that all of these forms of enjoyment share the musculature described by Duchenne, and are distinguished by their dynamics not their morphology. Similar questions can be raised about whether various forms of non-enjoyment smiles (compliance, embarrassment, grin-and-bear-it, etc.) are marked in the smile itself.

I also expect that it will be possible to use the same logic to distinguish actual instances of each of the negative emotions from deliberate performances of those emotions. In each case the actual negative emotional expression will include muscular elements that are difficult for most people to perform voluntarily. For example, most people cannot voluntarily contract the portion of the muscle in the lips which narrows the lip margin, and the absence of this muscular action should differentiate the deliberately performed from the actual expression of anger.

5. FACIAL MEASUREMENT

There are two different approaches for measuring facial expressions in muscular or anatomical terms. In one technique, human coders learn to recognize visually distinct facial actions that can singly or in combination account for all of facial movement. The Facial Action Coding System (FACS) (Ekman & Friesen 1976, 1978) allows for the scoring of any observed facial movement. C. E. Izard (unpublished data) developed a similar scoring system, but it includes only those facial movements which Izard believes are relevant to emotion†.

The other method is facial electromyography (EMG) in which surface electrodes placed over different regions of the face measure electrical discharge from contracting muscular tissue through the skin. The EMG

† This paper, entitled 'The maximally discriminative facial movement coding system (MAX)' is available from the Instructional Resources Center, University of Delaware, Newark.

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signal lends itself to immediate recording, is not labour intensive, and is sensitive to slight muscular movements that may not be visible even to the trained eye. One drawback is that EMG is highly obtrusive; the application of surface electrodes makes subjects aware of the facial measurement. Another drawback is that the recording selectivity of facial EMG is not muscle specific, but rather regionally specific, and it is not yet certain whether EMG allows the differentiation of as many different emotions as can be done with measurement that relies upon observer scoring of visible muscular actions. The first method – scoring observed facial movements in muscular terms – remedies these problems. It is precise, able to specify which muscles were active, and FACS allows measurement of any movement, not just an *a priori* set pre-determined by the placement of EMG leads. The visible movement scoring techniques are also unobtrusive, performed from videotape records without intruding on the subject. The disadvantage of this approach is that it is labour intensive and insensitive to very slight changes in muscle tonus.

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Discussion

E. T. Rolls (*Department of Experimental Psychology, University of Oxford, U.K.*). Do studies of ontogeny lend support to the hypothesis that measurements of facial (and autonomic) responses indicate that there is an innate, cross-cultural, basic set of face expressions? I wonder whether, for example, the facial expressions produced to tastes in the type of experiment pioneered by J. Steiner fit the hypothesis.

P. Ekman. There is a considerable convergence of evidence now supporting universal facial expressions of emotion. Work I described briefly in my paper fits very well with observations in many laboratories on the early development of facial expression, and also with some non-quantitative evidence on expressions in the blind.

D. I. Perrett (*Department of Psychology, University of St Andrews, U.K.*) If someone is instructed to raise or lower the corners of their mouth they might correctly guess that they are making their face look happy or sad. Once the subject realizes this, then the changes in emotion or affect that Professor Ekman has measured might be a consequence of the subject's knowledge that he/she is looking happy or sad. Does Professor Ekman have any evidence that the voluntary contraction of other groups of facial muscles is necessary or sufficient to 'drive' consequent emotional feelings?

P. Ekman. Of course the problem Dr Perrett mentions is a serious one and we tried to deal with it in the following way. We read the muscle-by-muscle instructions to a separate group of subjects, asking them not to move the muscles but instead to guess what emotion the instructions might be referring to. Although nearly everyone guessed the correct emotion for the surprise and the happiness instructions, almost no one could identify fear from the muscle by muscle instructions, and more than half of the subjects could not identify either anger or disgust from the muscular instructions. Thus we believe it is unlikely that most of our results could have been generated by the objects learning the emotion label from the instructions. Our findings on this question and a full discussion of this possibility are contained in Levenson *et al.* (1990).

H. D. Ellis (*School of Psychology, University of Wales College of Cardiff, U.K.*). In some of his earlier work, Professor Ekman, examined the putative asymmetry of facial expressions and the alleged cerebral asymmetry for encoding them. What does he think might result, autonomically, if he could get subjects to produce facial expressions that are mainly left or right sided?

P. Ekman. It is a very interesting question but a difficult one to test as very few people have sufficient facial control to contract muscles on one side of their face with no activity on the other side. It is especially difficult because most of the faces we ask people to make require activating not one but many facial muscles. I suspect if someone could make the movements unilaterally we would not, however, produce the distinctive, emotion-specific physiology we have observed so far, but it is quite an open question.

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